Under NASA's ORION Multi-Purpose Crew Vehicle (MPCV) Environmental Control and Life Support System (ECLSS) Project at Johnson Space Center's (JSC), the Crew and Thermal Systems Division has developed performance models of the air system using Thermal Desktop/FloCAD. The Thermal Desktop model includes an Air Revitalization System (ARS Loop), a Suit Loop, a Cabin Loop, and Pressure Control System (PCS) for supplying make-up gas (N_2 and O_2) to the Cabin and Suit Loop. The ARS and PCS are designed to maintain air quality at acceptable O_2, CO_2 and humidity levels as well as internal pressures in the vehicle Cabin and during suited operations. This effort required development of a suite of Thermal Desktop Orion ECLSS models to address the need for various simulation capabilities regarding ECLSS performance. An initial highly detailed model of the ARS Loop was developed in order to simulate rapid pressure transients (water hammer effects) within the ARS Loop caused by events such as cycling of the Pressurized Swing Adsorption (PSA) Beds and required high temporal resolution (small time steps) in the model during simulation. A second ECLSS model was developed to simulate events which occur over longer periods of time (over 30 minutes) where O_2, CO_2 and humidity levels, as well as internal pressures needed to be monitored in the cabin and for suited operations. Stand-alone models of the PCS and the Negative Pressure relief Valve (NPRV) were developed to study thermal effects within the PCS during emergency scenarios (Cabin Leak) and cabin pressurization during vehicle re-entry into Earth's atmosphere. Results from the Orion ECLSS models were used during Orion Delta-PDR (July, 2014) to address Key Design Requirements (KDR's) for Suit Loop operations for multiple mission scenarios.